Interaction Analysis for Supporting Students' Self-Regulation during Blog-based CSCL Activities

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ABSTRACT

Self-regulated learning is an important means of supporting students' self-awareness and self-regulation level so as to enhance their motivation and engagement. Interaction Analysis (IA) contributes to this end, and its use in studying learning dynamics involved in asynchronous Computer-Supported Collaborative Learning (CSCL) activities has rightfully increased in recent years. This paper presents a case study regarding the impact IA graphs have on students' self-regulation, during a blog-based learning activity. More specifically, 52 secondary education students – a control group (25 students without IA toolkit support) and an experimental group (27 students with IA toolkit support) – used a blog, as a communication and information management medium for creating Scratch games. The statistical analysis of their responses to the Self-Regulation Questionnaire, before and after the activity, indicates that IA graphs facilitated their self-regulation capacity. The results support the initial hypothesis, namely that IA constitutes an important module for self-regulation in CSCL settings, enhancing the collaborative learning activity.

Keywords

Interaction analysis, Self-regulation, CSCL, Blogs

Introduction

In all cases of CSCL, developments in learning theories – such as the sociocultural theory (Vygotsky, 1986) or the social constructivism theory (Kim, 2001) – underscore the significance of contextualisation and social interactions as fundamental constituents of the learning process (Bratitsis, 2010). This paper focuses on asynchronous communication (with peer support being the core objective), which is nowadays widely used in formal and informal educational contexts (Lucas, Gunawerdena, & Moreira, 2014). This way of learning is most likely to further grow and expand in the near future, due to the fact that the development rate and availability of social software applications – often collectively referred to as "Web 2.0" – has set new challenges, and offers novel opportunities for the learning technology community (Duffy & Bruns, 2006). Tools, such as blogs, discussion fora and wikis, are often utilized within CSCL, primarily for communicative purposes (Bratitsis, 2010). Blogs, especially, have emerged as social software catering for asynchronous communication, having the potential to become a space for reflection through discussion. Not only do blogs highlight the collaborative dimension of interaction, but may also accommodate metacognitive processes and collaborative construction of knowledge, thus influencing learning (Pavo & Rodrigo, 2015). Recent research offers evidence of the numerous benefits of using blogs, often associated with the improvement of students' critical thinking, problem-solving, and communication skills (Kim, 2008). For example, as all blog contributions remain at the disposal of the participants, referencing during discussion, as well as further revision and reflection, become more specific and accurate (Van den Boom, Paas, Van Merrierboer, & Van Gog, 2004). As Ellison and Wu (2008) suggest, blog writing incites critical and analytical thinking, since it allows students to experience a broader perspective when interacting, as well as review their interactions with their peers.

Much of the research conducted in the field of social knowledge construction focuses on the application of computer-based IA for the automated analysis and visualization of the social learning dynamics indicated by written interactions, in asynchronous blog-based environments (Dettori & Persico, 2008; Lucas et al., 2014; Pavo & Rodrigo, 2015). The participants of the learning environment are presented with the IA results, usually in a graphical format that can be interpreted by users, in order to encourage their participation in controlling the activity (Bratitsis, 2012). According to Dimitracopoulou (2009), the primary goal is to develop IA tools that could provide all actors involved (i.e., students and teachers) with an insight into their own current or previous activity, contributing to awareness, allowing them to reflect on a cognitive or metacognitive level, and, therefore, act in order to self-regulate their activities. Students, however, often find it difficult to have an overview of their performance and that of their peers on a group or community level, and this has a negative effect on their motivation to improve that performance (Bratitsis & Dimitracopoulou, 2009). In this vein, metacognitive skills are deemed necessary in order to manage one's cognitive skills and, thus, one's thinking process, through

regulating and controlling one's actions (Jermann, 2004). As Kitsantas and Dabbagh (2010) suggest, for students to self-regulate and navigate their own behavior, they must also be inherently motivated to attain goals. Processes linked to effective Self-Regulated Learning (SRL) include goal-setting, task strategies, self-monitoring and self-reflection (Pintrich, 2000; Zimmerman, 2000). Especially self-monitoring and self-reflection of the learning procedure, mainly through the analysis of social interactions, are core components of the SRL process in blog-based learning environments (Chen, 2009; Dettori & Persico, 2008). In this context, IA graphs allow students to self-regulate their activity, as research shows that such graphs activate metacognitive processes (Dimitracopoulou, 2009), and offer substantial help in raising students' awareness regarding their strengths and weaknesses (Bratitsis & Dimitracopoulou, 2009).

Addressing some of the aforementioned issues, the authors have developed an IA toolkit for blogs, which analyses and graphically visualizes, in real time, the complex social interactions that take place during blog-based collaborative activities. The toolkit enables teachers and students to use the automatically produced IA graphs in order to support monitoring, awareness, and self-regulation of the collaboration process. The present research aims to investigate the impact IA graphs have on students' self-regulation when involved in blog-based CSCL activities. Against this background, this paper presents research findings from a case study evaluating the application of our IA toolkit within a secondary education learning context. The paper is organized as follows: first, the related work supporting this case study is discussed, followed by a description of the research design and the research questions addressed in this paper. After the research findings are presented and discussed, conclusions and suggestions for future research can be found in the last section of this paper.

Related work

Pintrich (2000) describes SRL as an active, constructive process, whereby students set specific learning goals, select strategies purposefully in order to attain those goals, employ certain skills to assess progress, and make modifications when facing a problem. In that respect, Zimmerman (2000) conceptualized the SRL process as a three-phase model (forethought, performance, self-reflection), which was used by several studies to support self-regulation in online and blended environments (Kitsantas & Dabbagh, 2010). By engaging in these cyclical self-regulatory phases, students gradually become interested in the task, and reach a high level of self-efficacy in their ability to accomplish these goals (Zimmerman, 2008). Although SRL in web-based learning environments has received considerable academic attention (Zimmerman, 2000; Zimmerman, 2008), SRL, especially in educational group blog contexts, has not been studied extensively. Huang, Huang, Wang, Liu, and Sandnes (2012) classify the pertinent studies in three main categories: (a) analysis of online SRL behavior of learners (Perry & Winnie, 2006; Dettori & Persico; 2008); (b) application of the SRL strategy to web-based activities so as to assess its impact (Lee, Shen, & Tsai, 2008; Wong & Bakar, 2009); and (c) development of SRL-based tools, where providing IA graphs to help learners monitor self-learning is the prime objective.

Nonetheless, reviewing the literature in the field, one can detect a lack of available tools for the automated IA support of student awareness and self-regulation in blog-based CSCL. Focusing on asynchronous communication CSCL activities, one finds systems like the Knowledge Forum (Scardamalia, 2004), which provides metacognitive tools, assisting students to reflect upon their performance and improve their learning strategies in problem-solving situations, or the i-Tree for asynchronous discussion fora (Nakahara, Kazaru, Shinichi, & Yamauchi, 2005). The DIAS system (Bratitsis & Dimitracopoulou, 2009) is a discussion forum platform offering an extensive set of IA indicators addressing all actors involved in discussion learning activities. Similarly, the Web2SRL system (Huang et al., 2012) provides learners with the means to regulate learning, including planning, practice, and reflection. Furthermore, Chen (2009) has developed a personalized e-learning system with mechanisms that help learners improve their SRL ability. On the other hand, research on the self-regulation skills of students participating in blogs without any supporting IA tools has produced encouraging results in various settings (Dettori & Persico, 2008; Fessakis, Dimitracopoulou, & Tatsis, 2008; Bratitsis & Dimitracopoulou, 2009; Bratitsis, 2010; Fessakis, Dimitracopoulou, & Palaiodimos, 2013). It is true, however, that most of the cited researchers have studied self-regulation mainly by ex-post messages activity analysis of student interaction. Moreover, the IA graphs were produced off-line and in a non-automatic manner, usually in scheduled time intervals. Finally, research on the self-regulation level of participants has also been conducted in other areas, like Shared Knowledge Awareness (Collazos, Guerrero, Redondo, & Bravo, 2007), where the need to develop tools for self-controlling and self-monitoring the learning process is also highlighted. The main idea is the use of awareness visualization mechanisms as part of the knowledge management system, in order to help every member of the group complete the task in a more effective way.

Up to now, learning-oriented, fully-automated, and real-time evaluative or supportive tools, based on IA methods, have not yet been implemented specifically for blogs. Taking into account the above, and the fact that actual blogging systems offer limited IA support – often more useful to an administrator rather than a teacher or student – the authors of this paper have deployed a newly developed IA toolkit for blogs. This paper presents a case study of a CSCL blog-based activity in secondary education, while focusing on the impact the IA graphs of the toolkit have upon students' self-regulation during collaboration. These IA graphs are presented to the students as dynamically produced feedback information, in order to assist them in reflecting upon their own activity, as well as upon the overall activity by all participants, allowing them to self-regulate their actions and/or behavior. To the best of the authors' knowledge, there is no other significant input or comprehensive research work on the self-regulation effects of supporting automated IA tools for blogs, especially for secondary education students.

Research design

In essence, the current research constitutes a case study, where the pedagogical design of the CSCL activity was based on Zimmerman's model of SRL (2000) and Project Based Learning (PBL), which, according to Lee et al. (2008), can support and enhance the practice of SRL, especially in online learning.

Material

The main material employed for the purposes of this research was our IA toolkit, which can be seamlessly integrated in any WordPress blogging platform (as a plug-in), allowing teachers and students to use it so as to support monitoring, awareness, and self-regulation of the collaborative process (Michailidis & Tsiatsos, 2014). The innovative aspect of the toolkit resides in the fact that the IA graphs are produced automatically, and not after the completion of the blogging activity, by measuring quantitative activity data, such as the number of posts and comments written and read by someone, the identity of the writer or reader of those comments/posts, the time when they were written or read, etc. Furthermore, the effectiveness of the approach has been tested in real class teaching scenarios (Michailidis & Tsiatsos, 2014; Michailidis, Chondrouli, Katmada, & Politopoulos, 2015). In total, 32 visualized IA graphs (including all possible variations) can be produced and displayed by the toolkit, varying from simple statistical awareness information to complex cognitive and metacognitive IA graphs. For example, the graph entitled *Comments on All Articles* (Figure 1) is based on a gauge type chart, representing an overview of the active participation of the user, by displaying the total number of his/her comments (blue pointer) compared to the average number of comments made by all users of the blog (black pointer), and also the average number of comments made by the members of the user's team (white pointer). The graph provides metacognitive insight, by positioning the user in a colored 3-scale zone, using a predefined algorithm.

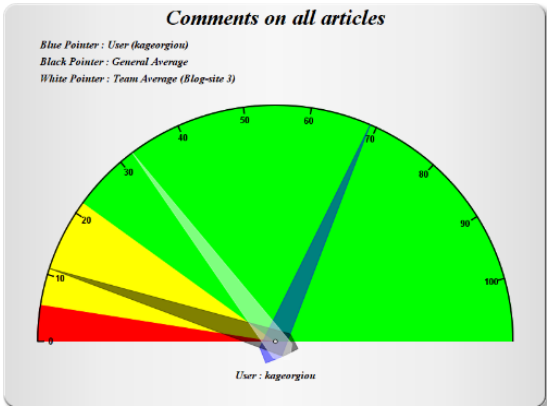

Figure 1. Screenshot of a graph produced by the IA toolkit

Research questions

The following questions have been set in order to assess the research goals:
RQ1: Is there a difference between the group of students being presented with the IA graphs from the toolkit and the group without exposure to the toolkit, in terms of message contribution in CSCL blog based learning environment?

We expect to find a positive relationship and an increase in message contribution, anticipating that the presence of the IA graphs from the toolkit will increase message contribution by the students belonging to the experimental group.

RQ2: Are there any statistically significant differences between student groups supported by the IA toolkit and student groups with no support from the IA toolkit for blogs, in terms of their self-regulatory capacity?

It is expected that the self-regulation level between student groups will differ, depending on the presence or not of the IA graphs from the toolkit. We assume that the experimental group members will report higher mean scores in self-regulatory capacity than students belonging to the control group.

Methodology

According to Dimitrov and Rumrill (2003), the design of this research could be characterized as "randomized control group pretest - posttest design." In this respect, participants are randomly divided into control and experimental groups, ensuring thus that they are of a similar average level in terms of technological expertise. As depicted in Figure 2, the overall activity conditions were the same for both groups (see section entitled "Procedure"). In order to explore the impact IA graphs have on students' self-regulation during blog-based collaboration, the only difference between the two groups was that only experimental group members had access to the toolkit's IA graphs.

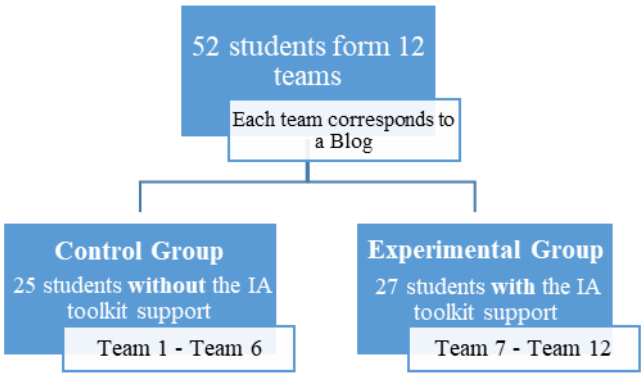

Figure 2. The research experiment schema

Participants

A total of 52 secondary education students (27 females, 51.9%, and 25 males, 48.1%), one teacher and one assistant teacher from a Junior High School in Thessaloniki, Greece, participated in the study. The average age of the participants was 13.5 years (*SD* = 0.5 years), since all students came from the same class. Out of the 52 students, only 25% had previous experience in blogging systems, while 53.8% of them had previous experience in other Web 2.0 environments. However, students had a satisfactory sense of confidence in using blogs (73.1%), with 52.6% of them declaring that they like using blogs, 42.1% being neutral, and only 5.3% of them being negatively inclined to blogging.

Instruments

The experimental instruments employed in this study include: (a) the published content of the blog (posts and comments), (b) the questionnaire that all students answered before and after the activity, (c) a semi-structured interview that was conducted after the completion of the activity, and (d) the graphs produced by the IA toolkit for blogs. The participating students were asked to complete two questionnaires: (a) the pre-test questionnaire, before starting the activity, and (b) the post-test questionnaire, after the activity. The statistical analysis was conducted via the use of SPSS package ver.22, with the level of significance set to 0.05. Both questionnaires used in this study were based on the Self-Regulation Questionnaire - SRQ (Brown, Miller, & Lawendowski, 1999). The SRQ is an instrument assessing the self-regulatory capacity of students through self-report, and it comprised 63 items specially designed to mark each of the seven sub–processes of the Miller and Brown (1991) model. The selected measures used a five-point Likert scale, ranging from "strongly disagree" (1) to "strongly

agree" (5). Cronbach's alpha statistics was performed to test the reliability of the pre- and post-task questionnaires; this revealed values of α = .894 and α = .703 respectively, showing high internal consistency for the applied questionnaires.

Procedure

The experiment was conducted during the 2nd trimester of the 2015-2016 school year. The activity was launched over a period of 8 weeks, and was a compulsory module for the successful completion of the Informatics course, contributing 10 units (out of 20) to the students' final mark. In order to achieve the objectives of this case study, a WordPress blogging network using our IA toolkit was deployed. Students were randomly divided into 12 teams, each of which had access to a team blog from the network, where they could post their articles and game designs and to a central blog, where they could read announcements. Only members of the experimental group were given access to the toolkit's IA graphs, and they were advised to consult them on a daily basis, throughout the activity. Students were assigned the task to design and develop a computer game using the Scratch programming environment (see https://scratch.mit.edu/). The role of the teacher was to monitor all the available IA graphs, providing guidance and support to students during the blog activity, and answering any questions during weekly 45-minute long face-to-face meetings. In order to support and encourage social interactions, the learning activity was organized with a collaboration script of 5 distinct phases:

- **Phase 1 – Socialization**: Students worked individually, in order to post an answer to a game design question, and comment on at least five answers of their fellow-students (1 week).
- **Phase 2 – Group Game Scenario**: Students had to post the scenario of their game as a team, and constructively comment upon at least five other group scenarios (2 weeks).
- **Phase 3 – Group Game Development**: Students had to work together as a team, and develop a beta version of their game in Scratch (3 weeks).
- **Phase 4 – Group Game Revision**: Students were obliged to interact with the rest of their peers in the blog by commenting freely upon the Scratch Games they had created, suggesting possible ways of improvement. Each team had to revise the beta version of their game, taking into account the comments of their peers, and post the final version of their game (1 week).
- **Phase 5 – Peer Marking**: Students had to suggest a mark, rating the final versions of the Scratch games, on a scale from 1 to 5 using a star-based system (1 week).

Results

Evaluating self-regulation based on number of comments

Overall, students produced a total of 1,665 messages. The groups which had no access to the IA graphs posted fewer comments (446 messages) than the students in groups that had access to the IA graphs (1,219 messages). In order to test if the presence of IA graphs did, in fact, contribute to the increase in the number of comments, the authors measured the significance of the difference between the students' comments of the two groups. Thus, two variables called *COM* (for comments coming from each student) and *GROUP* (to show whether a student belonged to the experimental or the control group) were created. Table 1 depicts the basic statistics for *COM* and *GROUP* variables.

Table 1. Descriptive statistics for *COM* and *GROUP* variables

Variable	GROUP (value)	*N*	Min	Max	Sum	Mean	*SD*
COM	Experimental (1)	27	10	115	1,219	45.14	33.04
	Control (2)	25	7	33	446	17.84	8.34
Total		52	7	115	1,665	32.01	27.91

First, a Shapiro-Wilk test was conducted to check if variables were approximately normally distributed. The results of the test showed that both variables were not normally distributed; ($S\text{-}W_{COM}$ = 0.749, df = 52, p = .00), ($S\text{-}W_{GROUP}$ = 0.636, df = 52, p = .00). Therefore, a Mann-Whitney test was conducted and indicated that the number of comments of students belonging to the experimental group (M = 45.14, SD = 33.04) were significantly higher than that coming from the control group teams (M = 17.84, SD = 8.34); U = 136.50, p = .00 (Neuhäuser, 2002). It is important to stress here that the effect size for this analysis (r = 0.51) was found to exceed Cohen's (1977) convention for a medium effect (r = 0.5).

Evaluating self-regulation based on the Self-Regulation Questionnaire (SRQ)

Regarding the evaluation of self-regulation, the SRQ was used to measure the self-regulatory capacity of the students before and after the study. The objective is to investigate whether there is a significant difference in the mean score of the self-regulation level between the control and the experimental group. Generally, in order to ensure that under all conditions the results deriving from the analysis supported our expectations, the following steps were taken. First of all, the fact that there was no difference in the mean score of the SRQ between the experimental and the control group before the activity had to be proven. In that way, our assumptions concerning a significant difference between the groups after the activity would be supported, proving that this difference was modified during the activity and specifically because of the use of the IA toolkit. Following this, the fact that the SRQ score for the control group students before the activity was not significantly different compared to that after the activity had to be put to the test as well. Finally, the fact that the toolkit had an impact only on those who used it, and that their SRQ score after the activity was significantly higher compared to their score prior to the activity also had to be tested.

For all the aforementioned reasons, a one-way ANOVA test was conducted, testing the difference before and after the activity, and ensuring that before the activity there was no difference between the groups concerning the SRQ score. In this case, the one-way ANOVA produces the same results as an independent sample *t*-test, since we aim to compare means of only two groups (Moore & McCabe, 1989). To this end, two dependent variables, called *PRE* and *POST,* were, therefore, created so as to keep the score of each student, as well as an independent variable, called *GROUP,* which aimed at indicating whether a student belonged to the experimental or the control group. Table 2 presents the basic descriptive statistics concerning the variables mentioned above.

Table 2. Descriptive statistics for the SRQ instrument

Variable	GROUP (value)	Name	*N*	Min	Max	Mean	*SD*
PRE	Experimental (1)	PRE_EXP	27	186	263	223.77	19.19
	Control (2)	PRE_CON	25	203	247	221	11.78
Total		PRE	52	186	263	222.44	15.97
POST	Experimental (1)	POST_EXP	27	207	278	242.51	18.28
	Control (2)	POST_CON	25	199	252	221.8	13.07
Total		POST	52	199	278	232.55	18.97

In order for the ANOVA to be applicable, there are specific prerequisites that need to be met, namely that the samples should be random and independent, and the variances of the populations should be equal. In our case, the samples were fairly random, because teams were formed using a list where the surnames of the students appeared randomly. In addition, the samples were independent, since they did not have any students in common. Moreover, a Shapiro-Wilk test was conducted and, based on the findings, all variables were approximately normally distributed ($S\text{-}W_{PRE}$ = 0.976, p = .367, a = 0.05), ($S\text{-}W_{POST}$ = 0.963, p = .108, a = 0.05). The homogeneity of variances was explored with the use of Levene's Test for Equality of Variances, which indicated the equality of variances, (F_{PRE} = *3.515*, p = .067 and F_{POST} = 3.356, p = 0.073).

The one-way ANOVA test indicated that the mean score of the SRQ in the experimental group before the study *(PRE_EXP*: M = 223.77, SD = 19.19) was not significantly different from that of the control group (*PRE_CON*: M = 221, SD = 11.78); $F(1,50)$ = 0.388, p = .536. Regarding the SRQ score after the study, the ANOVA test manifested that there was a significant difference between the experimental group (*POST_EXP: M* = 242.51, *SD = 18.28)* and the control group (*POST_CON*: M = 221.8, SD = 13.07). More specifically, the mean score of the experimental group was considerably higher than that of the control group; $F(1, 50)$ = 21.775, p = .00. Concerning the effect size of the test, the one before the study (η^2 = 0.007) is considered to be small ($\eta^2 < 0.13$) and the one after the study (η^2 = 0.3) is regarded as large ($\eta^2 > 0.26$) (Cohen, 1977).

The research findings described above illustrated that, on average, the students belonging to the experimental group achieved a higher SRQ score than the students from the control group after the completion of the experiment. This can be an indication that the experimental group did, in fact, significantly raise its self-regulation level, when compared to the control group, after the successful completion of the activity. This is a factor which was not present before the beginning of the activity. In other words, this can be an indication that the presence of the IA graphs produced by the toolkit supported and enhanced the self-regulation level of the participants.

The next step in order to prove that our IA toolkit for blogs had an impact only on the students that actually used it was to conduct a paired samples *t*-test test for the scores of the control group before and after the study. Two

variables named *PRE_CON* and *POST_CON* were created for the purposes of the test, which was to keep the score of each student of the control group before and after the study. With respect to the assumptions employed in the paired sample *t*-test, it is obvious that the samples are paired, since all of their members are common, except for the fact that the two variables measure the same score but in different times. Moreover, a Shapiro-Wilk test was conducted, and according to the results, all variables were approximately normally distributed ($S\text{-}W_{PRE\_CON}$ = 0.949, p = .235, a = 0.05), ($S\text{-}W_{POST\_CON}$ = 0.960, p = .415, a = 0.05).

As evident in the paired samples *t*-test, the mean score of the SRQ in the control group after the study (*POST_CON: M* = 221.8, *SD* = 13.07) was not significantly different from that before the study (*PRE_CON: M* = 221, *SD* = 11.78); $t(24) = -0.288$, p = .776. As expected, the effect size of the test is limited, only d = 0.027, which is considered to be small (Cohen, 1977). Moreover, the difference before and after the study was 0.8 units higher on average, indicating that the absence of the toolkit's IA graphs did not help students raise their level of self-regulatory capacity to a considerable degree.

Finally, in order to investigate if there is any significant difference as for the mean SRQ score of self-regulation of the experimental group only, before and after the activity, a paired samples *t*-test test was also conducted. For the test, two variables named *PRE_EXP* and *POST_EXP* were created in order to keep the score of each student before and after the study. Concerning the assumptions of the paired sample *t*-test, the samples are paired, since all of their members are common, except for the fact that the two variables measure the same score but in different times. Moreover, a Shapiro-Wilk test was conducted, and according to the results, all variables are approximately normally distributed ($S\text{-}W_{PRE\_EXP}$ = 0.976, p = .760, a = 0.05), ($S\text{-}W_{POST\_EXP}$ = 0.975, p = .750, a = 0.05).

The results of the paired samples *t*-test showcase that the mean score of the SRQ in the experimental group after the study (*POST_EXP: M* = 242.51, *SD* = 18.28) was significantly higher than that before the study (*PRE_EXP: M* = 223.77, *SD* = 19.19); $t(26) = -7.805$, p = .000. Concerning the effect size of the test, that is 0.723, which is considered to be medium (Cohen, 1977). More specifically, the difference before and after the study was 18.74 units higher on average, indicating that the presence of the toolkit's IA graphs helped students raise their level of self-regulatory capacity significantly.

Semi-structured interviews results

The increase in message writing activity was also confirmed by data collected during the semi-structured interviews of the students. Students admitted that the presence of the IA graphs from the toolkit motivated them to read and write more messages. As a student of the experimental group stated, *"… the graphs gave me extra enthusiasm for reading and writing more comments on my co-students' blogs and Scratch Game designs…"*, while another one claimed that *"… by monitoring the toolkit's IA graphs it was easier to write to more fellow students, even those I was not so familiar with…"*. Moreover, many students pointed out that they reflected upon and revised their posts and messages, if they realised through the IA graphs that their collaborators did not read as many of those as they had expected. In addition, this feature motivated students to be more careful when composing their messages, so as to support their design with references and examples. One could argue that the IA graphs functioned as additional motivation for the students to regulate their actions (increasing and improving their message contribution, while interacting more with their team members). As a member of the experimental group stated, *"…the graphs assisted my activity awareness and the contribution of my fellow students, and this made me write more constructive messages…"*. Indeed, not only was activity considerably increased, in terms of message reading and writing, but students tried to improve the quality of their participation as well. This can, consequently, be considered a form of self-regulation, stemming from the students' tendency to balance out their activity with that of the group they belong to. Motivation is directly connected to the students' self-regulation processes, and, as the majority of the students acknowledged during their interviews, it originates in their desire not to stand out, whether in a positive or negative manner.

Main findings and support data summary

This paragraph summarizes the main findings and support data concerning the research questions.

Regarding RQ1:

- The number of comments of students belonging to the experimental group were significantly higher than that coming from the control group students (*Mann-Whitney test results: U* = 136.50, p = .000).

- The main conclusion drawn from the comments the students made during the semi-structured interview was that the IA graphs from the toolkit functioned as additional motivation for them to regulate their actions.

Concerning RQ2:

- The mean score of the SRQ of the experimental group before the study was not significantly different from that of the control group (ANOVA test results: $F(1, 50) = 0.388$, $p = .536$).
- For the experimental group, the SRQ mean score after the study was significantly higher than that of the control group (ANOVA test results: $F(1, 50) = 21.775$, $p = .000$).
- The respective score of the control group after the study was not significantly different from that before the study (paired samples *t*-test results: $t(24) = -0.288$, $p = .776$).
- Finally, the mean score of the SRQ of the experimental group after the study was significantly higher from that before the study (paired samples *t*-test results: $t(26) = -7.805$, $p = .000$).

Discussion

The findings presented in the previous section can be further discussed in terms of the two RQs.

RQ1: Is there a group difference between the group of students being presented with the IA graphs from the toolkit and the group without exposure to the toolkit, in terms of message contribution in a CSCL blog based learning environment?

Based on the research findings presented in this paper, there is strong evidence that the presence of the IA graphs from our toolkit have a positive effect on comment production. This endorses our conclusion that the IA graphs generated from the toolkit have a significant impact on collaborative groups, helping them self-regulate during the blog activity, in order to increase their participation and overall engagement in the activity. These research results are consistent with those of previously conducted studies in the field (Fessakis et al., 2008; Fessakis et al., 2013). It is for this reason that the use of the IA toolkit is linked to amplifying learning, since the high-rate of message production and the overall increased interaction amongst blog participants are fundamental components of meaningful dialogue. Writing and posting more messages, revising these messages, as well as constantly commenting on answers by other blog participants, the students using the toolkit are more likely to diffuse opinions, constructive criticism, and eventually knowledge. Moreover, because of the IA graphs, students are often under the impression that their overall performance is constantly evaluated by teachers, thus motivating students to participate and collaborate further with their peers. All in all, it can be argued that, in terms of message production, the overall activity was enhanced, due to the presence of the IA graphs.

RQ2: Are there any statistically significant differences between student groups supported by the IA toolkit and student groups with no support from the IA toolkit for blogs, in terms of their self-regulatory capacity?

The real-time IA graphs produced by our toolkit raise individual and community awareness, as well as aim to facilitate rivalry among team members, and cater for drawing a comparison among groups. Taking into account the results from the SRQ, which measures the level of self-regulation capacity, we have detected that the statistical difference between the control and experimental groups is not present before the activity, but becomes considerably evident after the completion of the activity. This means that the IA toolkit's graphs used in the experiment had a significant impact on collaborating groups, assisting them to self-regulate during the implementation of the learning scenario in order to increase their participation and intensify their efforts. This is a strong indication that the presence of the toolkit's IA graphs not only supports, but can also enhance the self-regulation level of the participants, a result consistent with previously conducted studies in the field (Bratitsis & Dimitracopoulou, 2009; Bratitsis, 2010).

Conclusions, limitations, and future research

The current study recommends the application of an IA toolkit for blogs developed by the authors. This proposal is endorsed by other studies suggesting that computer-based IA provides educators with a tool to raise students' self-awareness and self-regulation level through analysing and monitoring interaction among users in asynchronous communication activities (Collazos et al., 2007; Dimitracopoulou, 2008). This paper advances the

research presented in previously published relevant studies (Michailidis & Tsiatsos, 2014; Michailidis et al., 2015), in order to examine the effect that the toolkit's IA graphs have on students' self-regulation, when participating in a blog-based CSCL activity. The research results are fairly positive, and consistent with those of previous studies (Fessakis et al., 2008; Bratitsis & Dimitracopoulou, 2009; Bratitsis, 2010; Fessakis et al., 2013). More specifically, the research data of the case study provide evidence to argue that the IA graphs automatically produced by our toolkit do, indeed, support and improve the self-regulatory capacity of students. The detected significant impact of the graphs generated by the IA toolkit on enhancing student's self-awareness and self-regulation level in group blog-based context may have implications for the design strategy of CSCL activities. As Collazos et al. (2007) confirm, the automated IA area of study is very important, because it can determine in what way collaborative activities could be designed in a better way. The quality and frequency of student's participation was also upgraded, due to fact that IA graphs assisted students while engaging in blog-based learning activities as members of collaborative groups. Moreover, it is very much appreciated by teachers, as the alternative, that is manual IA, is rather labor-intensive (Bratitsis, 2012).

The limitation of this study can be detected in the relatively small sample size. Aiming at further evaluating and validating the results presented in this paper, new case studies should be carried out in different educational and technological contexts, with larger sample sizes. This is actually one of our future work priorities, as we have already begun planning the same experiment shortly, but with a larger sample size. Moreover, teachers have increased information needs, due to the difficulty in identifying and evaluating each student's contribution and participation in group blogging. As Bratitsis (2012) argues, teachers are in need of support mechanisms in the form of automated IA tools. Thus, new case studies should be designed and implemented, with the teachers' special needs in mind. The main idea is to offer teachers the opportunity to see how they can be supported during blog-based CSCL activities, by further utilizing and evaluating our IA toolkit. Moreover, evidence has illustrated that IA graphs do not affect all students in a similar way or to the same extent. This calls for a larger number of thorough and sophisticated studies, which could eventually focus on tailor-made IA graphs, that is on detecting the most suitable sets of graphs for a specific learning situation or context.

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